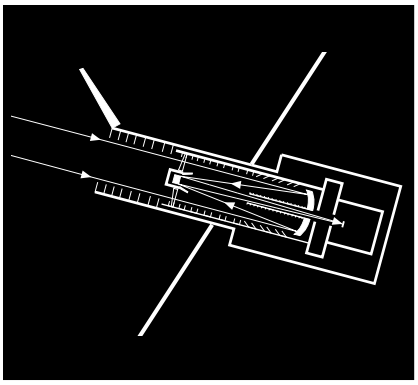


# Build Your Own Telescope

**Description:** A simple refractor telescope is made from a mailing tube, styrofoam tray, rubber cement, and some lenses.

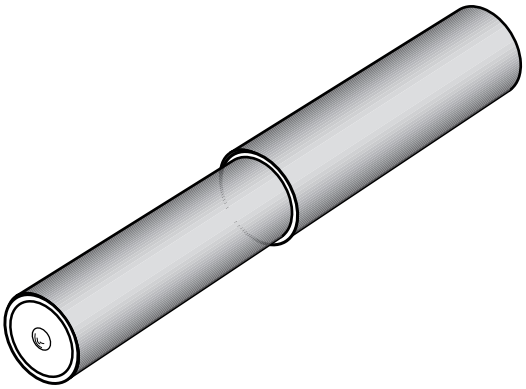
**Objective:** To build a simple astronomical telescope from two lenses and some tubes.

**Materials:**

- Paper mailing tube (telescoping - 1 inside tube and 1 outside tube)
- Styrofoam trays (1 large and 1 small)
- Lenses (1 large and 1 small. See note about lenses.)
- Metric ruler
- Razor blade knife
- Cutting surface
- Marker pen
- Rubber cement
- Fine grade sandpaper

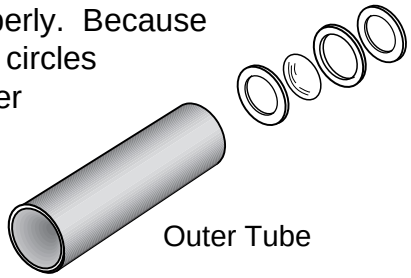
**Procedure:**

1. Cut a short segment from the end of the outside tube. This circle will be used for tracing only. Place the circle from the larger tube on the large tray. Using a marker pen, trace the inside of the circle on to the bottom of the tray three times.
2. Lay the large (objective) lens in the center of one of the three large circles. Trace the lens' outline on the circle.
3. Cut the circle with the lens tracing from the tray using the razor blade knife. Be sure to place the styrofoam on a safe cutting surface. Cut out the lens tracing, but when doing so, cut inside the line so that the hole is slightly smaller than the diameter of the lens.
4. Before cutting out the other two large circles, draw smaller circles inside them approximately equal to 7/8ths of the



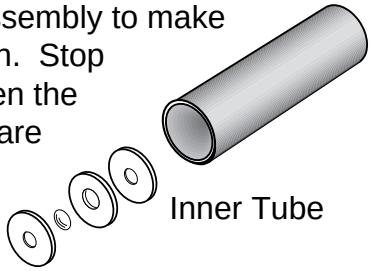
diameter of the large lens. Cut out both circles inside and out.

5. Coat both sides of the inner circle (the one that holds the lens) with rubber cement and let dry. Coat just one side each of the other two circles with cement and let dry. For a better bond, coat again with glue and let dry.
6. Insert the lens into the inner circle and press the other circles to either side. Be careful to align the circles properly. Because the outside circles have smaller diameters than the lens, the lens is firmly held in place. You have completed the objective lens mounting assembly.




7. Repeat steps 1- 6 for the inside tube and use the smaller lens for tracing. However, because the eyepiece lens is thinner than the objective lens, cut the inner circle from the small tray. The foam of this tray is thinner and better matches the thickness of the lens.
8. After both lens mounting assemblies are

complete, lay the fine sandpaper on a flat surface and gradually sand the edges of each lens completed mounting assembly to make them smooth. Stop sanding when the assemblies are just larger than the inside diameter of the corresponding tube. With a small amount of effort, the assembly will compress slightly and slip inside the tube. (Do not insert them yet.) Friction will hold them in place. If the lens assemblies get too loose, they can be held firmly with glue or tape.

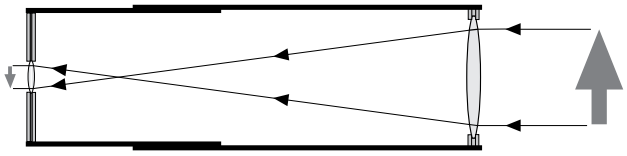



9. Hold the two lens assemblies up and look through the lenses. Adjust their distances apart and the distance to your eye until an image comes into focus. Look at how far the two lenses are from each other. Cut a segment from the outside and the inside tube that together equal 1 1/2 times the distance you just determined when holding up the lenses. Use the sandpaper to smooth any rough edges on the tubes after cutting.
10. Carefully, so as not to smudge the lenses, insert the objective lens assembly into one end of the outside tube and the eyepiece lens assembly into the end of the inside tube. Slip the inside tube into the outside tube so that the lenses are at opposite ends. Look through the eyepiece towards some distant object and slide the small tube in and out of the large tube until the image comes into focus.
11. (Optional) Decorate the outside tube with marker pens or glue a picture to it.

**Discussion:**

You just constructed a type of telescope known as a *refractor*. Refractor means that light passing through the objective lens is bent (refracted) before reaching the eyepiece. Passing through the eyepiece, the light is refracted again.

This refraction inverts the image. To have an upright image, an additional correcting lens or prism is placed in the optical path. Astronomers rarely care if images are right-side-up or up-side-down. A star looks the same regardless of orientation. However,



correcting images requires the use of extra optics that diminish the amount of light collected. Astronomers would rather have bright, clear images than right-side-up images. Furthermore, images can be corrected by inverting and reversing photographic negatives or correcting the image in a computer.

**Notes About Lenses and Tubes:**

Refer to the Lenses and Mirrors activity for information on how to obtain suitable lenses for this activity. PVC plumbing pipes can be used for the telescoping tubes. Purchase tube cutoffs of different diameters at a hardware store.

**For Further Research:**

- If the focal lengths of the two lenses used for the telescope are known, calculate the power of the telescope. Magnification equals the focal lens of the objective lens divided by the focal length of the eyepiece. Refer to the Light Gathering Power activity on page 56 for more details.
- Bring commercially-made telescopes, spyglasses, and binoculars into the classroom. Compare magnification, resolution, and light gathering power to that of the telescope made here. Learn how these optical instruments function.
- Invite local amateur astronomy clubs to host "star parties" for your students.